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THE TEACHING OF MATHEMATICS TO STUDENTS OF ENGINEERING[1]

WHAT IS NEEDED IN THE TEACHING OF MATHEMATICS TO STUDENTS OF ENGINEERING? (*a*) RANGE OF SUBJECTS; (*b*) EXTENT IN THE VARIOUS SUBJECTS; (*c*) METHODS OF PRESENTATION; (*d*) CHIEF AIMS.

By CALVIN M. WOODWARD, Professor of Mathematics and Applied Mechanics, and Dean of the School of Engineering and Architecture, Washington University.

I want to emphasize the point which Mr. Scott has just touched on, and that is that we often attempt too early to teach the subjects that require mature and reflecting minds. I want to tell you a story, a true biography of some one you all know of. He went through, in the city of New York, the whole range of mathematics, including analytic geometry and calculus. He learned his formulæ and definitions and "passed" in some manner, but, he told me, he did not know anything about them. He believed he was a dunce, and whenever he was required to make an intelligible demonstration, he could not do it; his teachers and his parents concluded that he was a dunce in mathematics, and could

[1] General discussion following the presentation of four formal papers (see SCIENCE, July 17, 24 and 31, 1908), and of the eight prepared discussions (see SCIENCE, August 7 and 28, 1908). Presented before Sections D and A of the American Association for the Advancement of Science and the Chicago Section of the American Mathematical Society, at the Chicago meeting, December 31, 1907.

never do anything in it. He would have gone through life with that notion, if some one had not offered him an appointment to West Point. He doubted his ability to pass the entrance examination in arithmetic; but his friends advised him to get an arithmetic and study. He bought a book and sat down and read the book through, and to his astonishment he found it easy. He passed his examination with flying colors. He entered West Point and graduated at the head of his class in mathematics, and is now at the head of a high grade technical school. If it had not been for the opportunity of going again over his whole course of mathematics, he would have gone to his grave thinking he had no capacity for mathematical analysis. That comes from poor or premature teaching.

I am opposed to putting college mathematics in high schools. Those young people may get a glimmer of it, but they get false impressions from it which are hard to remove. I have been teaching mathematics for forty years or more, and have been teaching applied mechanics for the same time. I taught Rankine for twenty-five years. It has always been my duty and my privilege to make my students see what mathematics was good for. And I want to defend the teachers of high school and freshman mathematics from what I think is unjust criticism. It is charged they do not make their students understand what mathematics is good for. It is simply impossible for them to do so, as I can do in mechanics. A man is very fortunate who can teach mathematics and then show what it is good for. I am old enough to quote a little of my early experience. I am led to it by something Professor Swain said in regard to mental processes. There is nothing so valuable to mathematical success as a clear grasp of fundamental principles. When I was preparing for college I gave all my time to Latin and Greek. I had done all my freshman mathematics and was reputed to be strong on that branch, when a new teacher came into the school who said, "Here's a new book in intellectual arithmetic, and I would like to have every student in the school go through it." It was fun for me, of course, but I went through the book from A to Z; no other mathematics that I ever studied did me so much good. The teacher's maxim was, "Take hold of the thread at the right end." That was the secret of his splendid teaching. I have applied that maxim to every branch of mathematics I have ever studied or taught. I have learned to take hold of mathematics at the right end, and in a measure I have taught my students to do so.

By B. F. Groat, Professor of Mechanics and Mathematics, School of Mines, University of Minnesota.

Most of the speakers have stated that what they were about to say had already been said by preceding speakers. I am going to try to state a general principle I have not heard clearly put since I came here. During the lunch hour Professor Slaught said that he had not heard a single general pedagogical principle brought out. I am going to take the honor to myself, to give expression to what seems to me to be a general educational principle.

Mathematics is mathematics and engineering is engineering. There is just as much art, science or principle in the teaching of mathematics as there is in the teaching of engineering and these two subjects should be distinguished, separated and kept separate. If you are going to teach engineering you must teach the pure principles. If you are going to teach mathematics you have got to teach pure mathe-

matics. Let it be pure or applied mathematics, it is the *principle involved* which must be taught. If this rule is not adhered to we shall find ourselves teaching something different from that which it was intended to teach.

The principle is that the technical courses in our engineering schools must be separated from our general educational courses. The technical courses are for the purpose of fitting the man for a special life work which is to come later on. The general education which he should have, by way of preparation, should precede his technical course as far as possible.

The straight technical course should be given as a course of two years extent, while the general and preparatory subjects should precede in a three- or four-year course.

The University of Minnesota has adopted a five-year engineering course. This is along the lines I am recommending and I prophesy that it will soon be extended to other schools and separated into two parts.

Let your professor of engineering teach engineering and your professor of mathematics teach mathematics. That is the general pedagogical principle I want to announce.

By C. S. HOWE, President, Case School of Applied Science.

I have been very much interested in the discussion of this subject because for thirteen years I was a professor of mathematics in an engineering school and during the past five years I have been endeavoring to reconcile the differences between professors of mathematics and professors of engineering. One thing in this discussion which strikes me as very peculiar is the sad lack of knowledge displayed by the engineering professors as to what is being done in mathematics in their own schools. I believe from my experience and from what I have seen in other institutions that the professors of mathematics are teaching mathematics most admirably as mathematics, but they are not teaching mathematics as a department of engineering. I do not believe that mathematics should be taught as a department of engineering. Mathematics is a science in itself and should be taught by specialists in that science if our students are to be trained in the proper way. The professor of mathematics has two duties to perform. One is to teach his students the principles of mathematics—that is, to teach them to reason and to understand why certain processes are right and why others are wrong. The student must also be taught how to use his mathematics so that he can solve any problem as soon as that problem is expressed in mathematical terms. Another duty of the mathematician is to teach the student to be exact. Unless the engineer is exact, unless he can obtain definite and reliable results in his engineering work, he can not succeed in his profession. This accuracy must be very largely taught in the mathematical department and much of the time and care bestowed upon classes is for the purpose of accomplishing this result.

I believe also that the professors of engineering are teaching engineering thoroughly and well. The difficulty which we are discussing to-day is not in the teaching of mathematics alone nor in the teaching of engineering alone, but in the connection between the two. The technical student is, I believe, taught pure mathematics well, but when he enters the class in engineering he finds that he has to deal with mathematics under a new form—that is, the particular engineering subject he is studying must be translated into mathematical terms and this is where he frequently meets with great difficulty. The student in algebra who has learned to solve equa-

tions of the first degree may have great difficulty with problems involving equations of the first degree because he has not learned to state the problems in mathematical language. So the student who begins electrical work finds certain problems containing known and unknown quantities, but not yet expressed in mathematical terms. Now I can not believe that it is the duty of the professor of mathematics to teach the student to express problems in the various branches of engineering in the form of equations or other mathematical terms. In order to do this it would be necessary for him to understand all the various branches of engineering and it is manifestly impossible for him to do this. The professor of civil engineering understands the problems of that subject and he should show the student in his department how to express these problems in such terms that the student can deal with them mathematically. The same may be said of each of the departments of engineering. When the professors of engineering have taught their students to state the problems of their own departments in mathematical language, then the student who has had the course in mathematics ought to be able to solve the problems, and if he can not he has not been taught his mathematics thoroughly or so much time has elapsed since he studied the subject that he has forgotten some parts of it.

Again, I believe that the professor of engineering should ascertain in a general way how mathematics is being taught in his institution and in just what form the student is using certain terms so that he may express his own problems in a way familiar to the student. If, for instance, in calculus the mathematical department has been using derivations, the professors of engineering in writing their problems should use differential coefficients and not attempt to express problems in terms of differentials. I know from experience that many professors of engineering do not do this and their students are confused by a difference of terms and not by a lack of knowledge of the subject. It is evident that the professors of engineering must conform to the methods of the department of mathematics because the department of mathematics can use but one method while the five or more departments of engineering might have several different methods. It is obvious, then, that for the sake of simplicity one method must be used and that method must be the method of the department of mathematics.

I also believe that the professor of mathematics should occasionally confer with the professors of engineering in order to find out from them just what mathematical subjects engineering students are weak in and what subjects it is especially desirable to have them well trained in and to see that his students are taught these things. Friendly conferences between the departments are of great value and should be encouraged by both the mathematicians and the engineers.

By Clarence A. Waldo, Professor of Mathematics, Purdue University.

In the table of hours for mathematics in the various institutions cited by Professor Townsend, the largest total stands against Purdue. Also a whole semester is assigned to trigonometry. Both of these conditions are in a measure due to the fact that we have recently passed through a transitional period in which for engineers solid geometry has been relegated to the secondary schools. The first semester was formerly divided between solid geometry and trigonometry. Now it is wholly given to the latter, while the second semester is set aside to college algebra. Experience shows that for the ordinary student college

algebra is more difficult than trigonometry and this determines their order in our program.

Placing trigonometry first and giving it so much time has developed with us several interesting facts.

1. Being easy to understand and having interesting applications, it naturally follows secondary work.

2. While trigonometry is easy to understand, yet to acquire facility in its use and absolute mastery over it as a fundamental science requires close and long-continued study, yet the student, ambitious to become an engineer, quickly sees that he must have facility in this subject and mastery over it.

As a subject of study, therefore, at the beginning of a young man's college career it is well adapted to give power and to instill habits of thoroughness, application, concentration and mastery.

3. Engineers have been recommending that a generous amount of time shall be given to trigonometry, at the expense of the calculus if necessary.

4. The subject is used to review and emphasize much of the preparatory mathematics, while it is also used to clear the way for that which is to come.

Another peculiarity in which Purdue stands almost alone we are quite prepared to defend. We do not crowd the pure mathematical work into the first two years, much less into the first year, but give it an hour less in the second year, than the first, yet at the outset of the third year, with his first course of calculus fairly mastered, we have the student well prepared to begin attack upon theoretical mechanics and kindred subjects. However, with two hours a week during junior year devoted to the further exploration of the calculus carried on side by side with its application to studies of a nature more or less professional, like thermodynamics, the student is likely to come finally into living contact with calculus ideas. Through three years, then, mathematical ideas are held persistently and prominently before the mind of the student, so that at the end of that time the mental change which I call the mathematical transformation is quite complete. If you are intent upon making a physical transformation by which a weak man becomes robust and powerful, you give one, two or three years for the muscles to grow and the chest to expand through long-continued and systematic exercise. Similarly the average student does not become habitually mathematical and exact in his thinking unless you give him careful direction and devote plenty of time to his development. The man who uses his memory and copies slavishly must disappear. In his place must stand the man of trained intellect, thoughtful, persistent, rich in expedients, powerful in attack. To produce him there are on the mathematical side two indispensable requisites, thoroughness in the fundamentals, and a sufficient time to make the mathematical attack of a problem habitual and natural, and to give such a control of and power in the use of the tools of mathematics that the solution of a problem of average difficulty shall be easy and pleasurable.

In the required mathematical part of the engineering courses at Purdue these are the considerations that determine the distribution of the work in the four-year program, and all of the time we are teaching not alone the particular subject that happens to be named in the curriculum—but mathematics.

Some years ago it was my fortune to study descriptive geometry under Marx and Von Derlin in Munich. They taught their subject from the standpoint of the mathematician rather than that of the draftsman. They made their students visualize geometric form in space and by

the use of that power discover methods of solving on paper synthetic problems of much difficulty. The German schools teach descriptive geometry as a mathematical subject, the American schools as a body of problems to be solved by rule on the drawing board. The former method makes descriptive geometry the finest discipline of the four years' course; from the other method little educational benefit arises. Some years ago at the Rose Polytechnic, where for a time we taught descriptive geometry in the German way, it was not unusual to meet students who declared enthusiastically that they got more real good from this subject than from anything else in their entire course.

I would ask the new committee to inquire how and by whom descriptive geometry should be taught?

By C. B. Williams, Professor of Mathematics, Kalamazoo College.

The teachers of mathematics in the small colleges of the middle west are preparing many men for work in the better technical schools. From our standpoint there is substantial agreement between the two representatives of the Massachusetts Institute of Technology (Professors Wood and Swain). They expressed themselves so differently that one might easily fail to see how closely they agree. Both want longer and stronger courses in mathematics in the secondary schools. I would like to know the college teacher of mathematics who does not agree with them. They want more mathematics taught and to have it taught better, to have longer and more consecutive mathematical courses in the secondary and primary schools. In other words, the faculties of the technical schools and colleges are working toward the same end, that is, to have more effective courses in primary and secondary mathematics so that college students can do more and better mathematical work. If we could have properly prepared students, we could turn out the kind of men the better technical schools should have.

The engineers and teachers of engineering have insisted that the most necessary qualification for a real engineer is that he should be able to realize his mathematics, to "think mathematically," as they express it. The mathematicians want the same thing. We are trying to make use of and to train the faculty of geometric intuition, to emphasize the functional notion and to develop functional thinking. There is substantial agreement that the best way to do this is through geometry, with perhaps some help from elementary mechanics. It is true that sometimes we are tempted to use too big and complicated machines for little problems, but this is only because we are attempting to develop methods powerful enough to solve big problems.

By J. B. Webb, Professor of Mathematics and Mechanics, Stevens Institute.

Every practical problem requiring mathematics for its solution consists of three parts:

(*a*) An *Analysis,* which resolves the problem into its elements, examines these in the light of natural laws, rejects unimportant ones and defines the relations existing between those upon which the solution depends. This involves the adoption or discovery of methods of measuring the elements, so that they may be expressed quantitatively by symbols, and of the reduction of the relations between them to the standard mathematical forms of expression. The result is a *mathematical statement of the problem* by one or more *equations.*

(*b*) A *solution* of the equations by which the relations sought for between the quantities are clearly expressed or the quanti-

ties put in proper form to have their values calculated.

(*c*) The *interpretation* of the result, which involves a translation of the same from the mathematical language in which it has been obtained into the original language of the problem and a discussion of the practical bearings of the same.

In conversation with a fellow mathematician at this meeting he surprised me by saying that he expected a problem to be put into mathematical language before it was submitted to him and I presume he did not feel bound to interpret his results. Now if "pure mathematicians" regard practical problems in this way, engineers and other practical men have just cause for finding fault with "pure mathematics," and to teach mathematics in this way is to render it valueless to most students. Personally I should refuse to undertake a problem unless I made the analysis and interpretation as well as the solution.

In many if not in most problems the analysis and interpretation are the main parts. They require a broad knowledge of practical conditions and of other sciences and are far more interesting than the mere solution, especially as they often bring into play a large amount of ingenuity and invention, as well as imagination and judgment. A mathematician who can not make the analysis and interpretation of a problem is not to be trusted with the solution and an engineer who is fully competent to make them had better undertake the solution himself or put the whole problem into the hands of a mathematician fully competent to undertake it.

There is no excuse for a "pure mathematician" remaining ignorant of the practical side of the problems he teaches, and his mathematics will not be interesting or trustworthy. Let him cultivate the acquaintance of the truly educated engineer, who will be only too glad to discuss problems with him and give him all the practical information he needs. But there are too many engineers who are not truly educated and who know less about mathematics than the "pure mathematician" does about practical things, and they ought to cultivate the acquaintance of the mathematician and rub off the worst parts of their ignorance before they attempt to criticize the teaching of mathematics. But it is much easier to find fault and say that they never found any use for such and such mathematical branches, when they never gave them enough attention to make them of any use.

Every mathematical teacher should teach all three parts of a problem, but the average engineering student is so indifferent to real progress and his limited time is so taken up with other things that he may get through his course knowing very little about mathematics, no matter how well it may be taught.

Students with fair ability that really want to learn a particular subject can do it even under indifferent teachers, but unless students exert themselves to learn, the best teacher can not put knowledge into them. Discuss the subject to the limit, analyze and adjust the engineering courses to a nicety, write new text-books, adopt new systems and get new teachers and the thing will remain about as it is; teachers will teach and students will expect them to, while only a few will learn, whether the teacher expects them to or not.

By H. T. EDDY, Dean of the Graduate School and Professor of Mathematics and Mechanics, College of Engineering, University of Minnesota.

Complaint has been made that in our teaching of mathematics we do not pay due attention to psychological and pedagogical principles. I want to consider for a mo-

ment the application of two of these principles.

First, it is necessary for the engineering student to have an ample undergraduate course in mathematics, and such an extended drill in and habitual acquaintance with its processes that when he has forgotten nine tenths of it, just as he will of this and all other subjects which he studies in college, what remains with him will be a sufficient equipment in this line for his professional career. In other subjects his residuum of knowledge is easily refreshed and increased. Not so in mathematics. The stock of mathematical knowledge of which he is easily master on entering his profession will practically be the end of his attainments in that direction. Restricting the course in mathematics to bare essentials is suicidal, for of it a small fraction only will remain as a permanent possession, and that fraction is likely to be smaller, the smaller the amount originally attempted.

Second, the teacher of mathematics is prone to think that a clear presentation of mathematical truth on his part, and a logical demonstration by the student, are all that is required in this subject. But important as these things assuredly are, they are insufficient to produce successful results. The question is one in which human interest is really of more importance than logic, for mathematical knowledge can not be successfully imparted unless genuine interest on the part of the student can be in some way aroused. It goes without saying, that the teacher must first of all have that interest himself or he ceases to be a fit teacher. How he will awaken interest in his pupil depends upon his own personality. Many do this by help of problems which elucidate and apply the principles. Just here lies the reason for the usual inability of professional engineers to teach mathematics. They have no interest in mathematics itself. It is the engineering problem alone that interests them. To this matter of interest, or the lack of it, may be traced the failure which is apt to attend the separation of classes into divisions according to scholarship, for in that case the divisions made up of poor students lose the impetus to be derived from the interest which the good students exhibit in their work in which all participate to some degree.

By S. M. Barton, Professor of Mathematics, University of the South.

While standing here in the heart of the modern, bustling city of Chicago, and listening to this discussion, my mind goes back to the ancient city of Tarentum and her distinguished governor, Archytas. Archytas, while an able mathematician, was too practical, as we learn, to suit the ideas of the Platonic School, who objected to his mechanical solutions of certain mathematical problems as interfering with pure reasoning. Now, while I take an immense interest in applied mathematics (what mathematician at this day would not?) yet I confess to a feeling of sympathy with Plato in his condemnation of Archytas. At any rate I wish to enter my protest against a possible tendency to degrade mathematical teaching to the memorizing of thumb-rules, and to urge the advantage of a strong backbone of pure mathematics in our engineering courses.

I read with interest a paper presented at the Ithaca meeting of the Society for the Promotion of Engineering Education, by Professor Arthur E. Haynes of the University of Minnesota, in justification of the use of the expression "engineering-mathematics." I must say I was at first somewhat shocked by the expression, for I had always believed that *mathematics is mathematics* take it when and where you will. While I would agree heartily with

much that Professor Haynes said, and I do not doubt that his courses are interesting and instructive, yet I question the wisdom of drawing any sharp distinction in the college curriculum between the mathematics given to the engineering student and to any other class of students.

I find myself differing absolutely from the gentleman from the Massachusetts Institute of Technology, who apparently sees no beauty, much less utility, in the higher branches of pure mathematics. How Professor Woods, who has, by the way, written such a sound text-book on mathematics, can live amicably in the same state, much less in the same college, as his engineer-colleague, I am at a loss to understand—perhaps they have an occasional fight. But, joking aside, there is a dangerous tendency to adopt rules (slide and mental) and short-cut, approximate solution to the utter exclusion of rigid proofs. Is it wise to make a mere machine of the young engineer, even if thereby he becomes rich faster or grows poor less slowly? I freely admit, however, that too much theory would be disastrous, and that there is great room for improvement in the teaching of mathematics. The student should be taught how to use his mathematics, and the existing gap between theory and practise be bridged. While affording every possible facility to the student for making experiments, collecting data, becoming expert in handling instruments, making calculations, etc., I urge that we give them, one and all, a good rigid course in *pure* mathematics.

By ARTHUR E. HAYNES, Professor of Engineering-Mathematics, University of Minnesota.

I have been called upon, by name, to defend the use of the term, "Engineering Mathematics." The justification of the term will be found in my paper on the subject in Volume XIV. of the Proceedings of the Society for the Promotion of Engineering Education. As the paper was not read before this association, many of the members present are not acquainted with its contents.

In brief, the reasons there given for the use of the term are:

(*a*) Because of the main object of the study of mathematics in engineering courses, viz: its use as a tool.

(*b*) Because of the proper method of teaching the mathematics of such courses.

(*c*) Because of the content of the mathematics of such courses.

It is not a degradation of mathematics to make it practical, it is rather an added glory. It is as justifiable to use this term as to use the corresponding terms agricultural chemistry, agricultural botany, engineering drawing, etc. We do not degrade chemistry or botany or drawing by the use of these terms: but their employment is justified by the objects of the study, by the methods required in teaching them and by their content, as in mathematics.

It has been suggested that a less thorough study of mathematics is advocated. In reply to this, may I quote from an article in Volume VIII. of the Proceedings of the Society for the Promotion of Engineering Education, on "The Teaching of Mathematics to Engineering Students," where in speaking of such teaching I said:

(*a*) It should be of such a character as to produce an enduring stimulating effect upon the mind of the student.

(*b*) It should give the student the power to properly interpret mathematical language, and to accurately and skillfully use it.

(*c*) To secure these results, the teaching must be based upon a proper order of studies and carried forward in a rational, intelligent manner.

By Arthur S. Hathaway, Professor of Mathematics, Rose Polytechnic Institute.

In a paper on "Pure Mathematics for Engineering Students," published in the *Bulletin* for March, 1901, I expressed opinions which coincide with those given here to-day. I then said that instruction in mathematics for engineering students should have two objects (1) to develop an engineering mind, and (2) to develop mathematics as an instrument of research for the engineer. I came to these conclusions at that time as a result of inquiries made of graduates of several institutions, who were in engineering practise, and of their employers. From the latter, I have had the statement that it is inadvisable to place a man in the higher positions in engineering who has not had a good mathematical training, especially, in the calculus, which, they assert, develops those modes of thought which are necessary to the engineer.

I wish to call your attention to the fact that the fifty-four hours of analytical dynamics credited to Rose Polytechnic Institute on this chart are spent on applied calculus. There is a regular course of one hundred and forty-four hours in Rankine not mentioned here, which is given by my colleague, Professor Gray. In applied calculus we take up problems which require the use of the calculus, such as motions in constant, elastic and central fields, the bending of beams, the twisting of shafts, problems in electricity, in chemistry, etc. We take problems gathered from all sources, text-books, magazines, engineering professors, and discuss them in the class-room, with special reference to the analysis and its mode of application.

By Edward V. Huntington, Assistant Professor of Mathematics, Harvard University.

I desire to call attention to the fact that besides the analogy of mathematics as a tool or instrument, there is also the perhaps more significant analogy of the mathematician as the discoverer of quantitative relations which already exist in the problems themselves. Logarithmic relations between varying quantities, for instance, are not dragged into the problem from some artificial tool-chest, but are already present in the problem, and are analyzed out of the problem much as the precious metal is analyzed out of the ingot by the metallurgist. The practical mathematician is simply a scientist specially trained to perceive the quantitative aspects of physical phenomena.

By Donald F. Campbell, Professor of Mathematics, Armour Institute of Technology.

We have had a number of good ideas set before us in the last two days—ideas which we ought to make an effort to crystallize. I think that the present time is the psychological moment to have a committee appointed to draw up a report on mathematics for colleges of engineering. This report perhaps might be in the nature of a symposium, but it would be especially valuable if it considered in detail the subjects which should be emphasized in a course in mathematics for engineering students. These, however, are merely suggestions. I would not hamper the committee in their deliberations by outlining any particular course which they should pursue. The only condition which I would impose is that the committee be representative enough that all of us can look towards their report with the utmost confidence.

I would move that the chairman be empowered to appoint a committee of three, these three to increase their number to fifteen, chosen from among the teachers of mathematics and engineering and the practising engineers, these fifteen to con-

stitute a committee authorized by this meeting to make such a report on mathematics for colleges of engineering as in their opinion will be of service to teachers in such institutions, and to submit this report when completed to the Chicago Section of the American Mathematical Society.

THE INTERNATIONAL GEOGRAPHICAL CONGRESS[1]

THE ninth International Geographical Congress, which began with a reception on Sunday, July 26, ended on August 6 with a banquet given by the Council of State of the Canton of Geneva. The congress has been marked by one unique feature—its unprecedented length. Hitherto a week has been the limit of the session of these congresses, and why the Geneva congress should have been protracted to the weary length of thirteen days it is difficult to surmise.

On the social side Geneva has hardly been surpassed by any city in which the congress had previously met. From the president of the republic downwards every one has vied in making the 750 members of the congress feel that they were welcome.

The membership was thoroughly representative, and the discussions in the sections, as well as the daily intercourse outside the sections, between geographers of all nationalities, are sure to lead to good results, to a clearer conception as to the field of geography, and as to the best methods of solving the many problems with which it has to deal. As usual, the educational side of the subject gave rise to much discussion, a good deal of it of little value from the practical point of view, but still not without its uses. Perhaps on the whole the discussions on glaciation in the section devoted to that subject were of wider bearing and of more scientific value than those in any other section; but they had as much to do with geology as geography, as, indeed, was the case with subjects brought before certain other sections. Geography has quite a wide enough field of its own, without having to burden itself and overweigh a congress with matters outside its sphere. Perhaps the lecture that attracted most attention and had the widest hearings was that of M. Ch. Lallemand on the "Respiration of the Earth." M. Lallemand gave a clear exposition of the researches of Professor Eckert, of Potsdam, which seem to show that there is a daily tide on the surface of the earth, of small dimensions may be, but absolutely real. Other lectures deserving special mention were those of Professor Oberhummer, of Vienna, on Leonardo da Vinci and his influence on the geography of his time, and on the great cities as individuals; of Dr. Filchner, on his masterly exploration in Eastern Tibet and the region between the Hoangho and Yang-tsze; and of M. Alexandre Monet, on the Scarab containing the record of the circumnavigation of Africa under King Necho, this last leading to a vigorous discussion. Dr. Otto Nordenskjöld's account of the results of his Antarctic expedition, though not altogether new, suggested several interesting problems. An unusual feature was the exhibition, with interesting explanations by Frau Wegener, of a remarkable collection of Chinese paintings collected by herself, and supplementary to some extent to her husband's account of his expedition in central China.

At the London congress in 1895 a committee was appointed at the suggestion of Professor Penck, now of Berlin, for the purpose of securing international action for the construction of a map of the world on the scale of 1 to 1,000,000, about sixteen miles to the inch. The scale has been adopted as a sort of standard scale, but otherwise little progress has been made. At Geneva those interested in the scheme decided to form a committee for the purpose of agreeing upon lines on which the proposed map should be constructed. After one or two meetings the committee came to definite conclusions, not only as to the scale, but also as to the symbols to be adopted to represent the various features on the map, the lettering to be used, the size of the sheets, the initial meridian (Greenwich), the use of the metric system (along with others if desired by individual states), and other points.

[1] Abridged from an article in the London *Times*.

These proposals were adopted at the concluding meeting, and will be submitted to the governments and societies of various countries, and it is earnestly to be hoped that steps will at once be taken to carry the proposals into practise, and so prepare the way for a standard map of the world. Similar steps were taken for the formation of an International Cartographic Association for the issue of standard maps showing at a glance the progress of exploration in each country. Another scheme brought before the congress was that of M. Lecointe, of Brussels, for the establishment of an International Polar Commission. The congress agreed that it was desirable to submit the scheme to the governments interested, but there is a strong feeling in certain influential quarters that any such scheme is unnecessary, at least so far as those countries most interested in polar exploration are concerned. The proposal of Captain Roncagli, secretary of the Italian Geographical Society, for the establishment of an International Bureau for the dissemination of commercial information as to new countries was approved, apparently without realizing what it implied. Another resolution adopted by a large majority was that France should adopt the Greenwich meridian, that the hours of the date should be enumerated consecutively from midnight to midnight, and that all public clocks, including those of railways, should be regulated according to the legal hour. A commission which may lead to interesting results was agreed to for the creation of a collection of photographs illustrating the various forms of the earth's crust, and another for the more thorough exploration of the Atlantic Ocean and the Mediterranean.

After a keen debate as to the next place of meeting—Lisbon, Budapest and Rome having put in claims—the last-named was adopted, and the date fixed for 1911, when Italy will celebrate the fiftieth anniversary of her independence.

REPORT OF THE BRITISH FISHERIES COMMITTEE

The report of the committee appointed to inquire into the scientific and statistical investigations now being carried on in relation to the fishing industry of the United Kingdom has been published. The committee, consisting of Mr. H. J. Tennant, M.P. (chairman), the Hon. C. H. W. Wilson, M.P. (now Lord Nunburnholme), Sir Reginald MacLeod, Under-Secretary, Scottish Office, Mr. N. W. Helme, M.P., Mr. Archibald Williamson, M.P., Mr. P. Chalmers Mitchell, D.Sc., F.R.S., Mr. J. Stanley Gardiner, F.R.S., the Rev. W. S. Green, C.B., chief inspector of Irish fisheries, Mr. R. H. Rew, Board of Agriculture and Fisheries, Mr. L. J. Hewby, treasury, with Mr. A. T. Masterman, D.Sc., Board of Agriculture and Fisheries, as secretary, was appointed to "inquire into the scientific and statistical investigations now being carried on in relation to the fishing industry of the United Kingdom by the fishery departments of the government, the Sea Fisheries Committees, the International Council for the Exploration of the North Sea, and the Marine Biological Association; and to report what work of this character is required in the interests of the fishing industry, and by what methods or agencies it can be most usefully and economically carried out in future."

In its report the committee submits recommendations which are summarized as follows:

1. The establishment of a central council for the United Kingdom which shall have control of public funds for fishery investigations of a national and international character.

2. The strengthening of the Board of Agriculture and Fisheries as the central fishing authority for England and Wales, and the provision of additional funds to this board for the encouragement of local work.

3. The continuance of adequate provision to the Fishery Board of Scotland for local scientific research.

4. The continuance of international cooperation in scientific and statistical investigations upon a definite and permanent basis.

5. The continuance of the annual grant of £1,000 to the Marine Biological Association of the United Kingdom.

The central council should, it is suggested, subject to certain qualifications, be empowered:

1. To expend, or allocate and direct the administration of, such funds as may be voted by Parliament for scientific investigations into questions affecting the common interests of the sea fisheries of the United Kingdom.

2. To draw up such schemes of investigations as the council shall from time to time deem desirable for the solution of practical problems affecting the sea fisheries generally.

3. To arrange for such statistical investigations as the council may deem desirable with the departments charged with the duty of collecting fishery statistics, and to place so far as practicable such statistics on a uniform basis throughout the United Kingdom.

4. To arrange for the coordination of schemes of investigations under their direction with any similar schemes undertaken by other nations interested in fisheries frequented by British fishermen.

5. To select, direct and, if necessary, to equip any agents for the conduct of such investigations as they may require to be carried out.

6. To take over or acquire vessels properly equipped for fishery investigations.

7. To present to the treasury and to each of the ministers having charge of fishery departments an annual report on the progress of the investigations under their direction and on the results from time to time obtained.

SCIENTIFIC NOTES AND NEWS

THE honor of knighthood has been conferred on Professor A. G. Greenhill, F.R.S., the eminent mathematician of the Ordinance College, Woolwich.

SIR WILLIAM RAMSAY was made an honorary doctor of medicine at the University of Jena on the occasion of the celebration of the three hundred and fiftieth anniversary of its foundation.

DR. GEORG QUINCKE, professor of physics at Heidelberg, and Dr. Friedrich Hildebrand, professor of botany at Freiburg, have celebrated the fiftieth anniversary of their doctorates.

DR. REYE, professor of mathematics at Strasburg, has retired from active service.

DR. HENRY M. HURD, superintendent of the Johns Hopkins Hospital, has been appointed a member of the Maryland state lunacy commission, vice Dr. Charles F. Bevan, retired.

PROFESSOR G. W. WILSON, of Upper Iowa University, Fayette, Iowa, has held during July and August a research scholarship at the New York Botanical Garden.

A PRIZE founded in honor of the late J. P. Moebius, the neurologist, will be conferred for the first time next year.

M. ANTOINE HENRI BECQUEREL, the eminent French physicist, has died at the age of fifty-six years.

KANSAS City has begun work upon its new Zoological Gardens, which it is said will be completed in the course of the next five years at a cost of about $500,000.

MRS. REID, widow of the late Thomas Reid, who was president of the Bermuda Natural History Society and mayor of Hamilton, has given $2,500 to the Bermuda Aquarium and Biological Station.

PRESS dispatches state that Count Zeppelin has announced that he intends to found an institute for the investigation of the problems of air navigation in the interest of German industry, defence and science. The contributions made by the public, he says, are now far beyond the sum necessary to replace the destroyed airship and beyond the sum he intends to accept toward the recuperation of his private fortune which was spent in airship experiments. All of the surplus now on hand and all further contributions will be added to the endowment of the institute. The Bank of Stuttgart, which is receiving the subscriptions, has $500,000 deposited to Count Zeppelin's credit, and about $250,000 has been subscribed but not yet paid.

A CONGRESS on thalassotherapy, or treatment of disease by sea air, sea bathing, etc., will be held next September at Abbazia, near Fiume, on the southern coast of Austria.

AT a meeting consisting of representatives of temperance organizations interested in the International Anti-alcohol Congress, which has been held during the past twenty years

in various continental towns, it was agreed to invite the congress to meet next year in London for the first time. That invitation having been accepted, arrangements are now being made for the twelfth congress to be held during the week beginning July 18, 1909. The congress, which is to last a week, will probably meet at the Imperial Institute, and the delegates will be present from nearly every country in the world.

Dr. W. D. Matthew, one of the members of the American Museum Expedition to Nebraska, has recently returned from the field. The investigations of the party have been confined mainly to the Miocene beds of Sioux County. Much interesting material has been collected from the Lower Miocene in the vicinity of Agate; and farther to the south, Dr. Matthew and Mr. Harold Cook discovered two new fossil-bearing levels from which were obtained collections especially rich in fossil horses. Several incomplete skeletons of the Middle Miocene horse have been secured, together with abundant fragmentary material from a higher level which may prove to represent a new and large fauna that hitherto has been very little known.

The expedition to James Bay and vicinity by Mr. Alanson Skinner, for the American Museum of Natural History, has obtained not only ethnological material from the Cree Indians, but much new information regarding their religious and social customs. The Cree are essentially hunters, and the complete set of specimens brought back by Mr. Skinner will add greatly to the ethnological interest of the collections already installed in the museum halls. Mr. Skinner's attempt to study the Naskapi (a little-known tribe) was fruitless, as the Indians no longer frequent the east coast of Hudson Bay, but remain in the country bordering the Atlantic. The members of the expedition covered more than a thousand miles in an eighteen-foot canoe, and narrowly escaped starvation while returning through the forests of northern Canada.

According to the Paris correspondent of the London *Times*, the *Pourquoi Pas*, conveying the Charcot mission on the second voyage of discovery of its commander, Dr. François Charcot, to the Antarctic regions, left the port of Havre on August 16. Some 30,000 persons bade it God-speed from the quays, and a little company of distinguished guests were present at this dramatic leave-taking. Among them were M. Doumer, whose intervention secured from the French parliament a subsidy of $160,000 for the expedition. Dr. Charcot expects to be absent about two years. One of his objects in returning to the regions of the South Pole is to bring back samples of the fossils to which Dr. Nordenskjöld has already drawn attention. He intends to transport them to one of the open ports of the Antarctic continent, either Port Lockroy or Port Charcot, and then to go on to Loubet Land to begin his exploration of the regions to the south. He takes with him provisions for twenty persons for more than two years. The *Pourquoi Pas* will reach the southern ice at the beginning of the austral summer towards December 15, at about 800 kilometers south of Cape Horn. Dr. Charcot's staff will then have their work cut out for them. They include M. Bougrain, who will make the astronomical observations; M. Rouch, specialist in meteorology and oceanography; M. Godefroy, who will study the hydrography of the coast and the tides; M. Gourdon, geologist, and Dr. Jacques Liouville, marine zoologist and botanist. The commander himself is a good bacteriologist.

The measures devised by the governor of Uganda, Sir Henry Hesketh Bell, for combating the spread of sleeping sickness are, according to Reuter's Agency, meeting with a considerable measure of success. During 1907 there were no new cases among Europeans, and the deaths among natives during the twelve months numbered less than 4,000. The whole of the population has been removed from the shores of the Victoria Nyanza, and it is hoped that the disease-carrying fly in that belt, if not reinfected, will gradually cease to be a source of danger. Several thousands of the sufferers from sleeping sickness are being maintained in segregation camps, but the treatment by atoxyl is not proving of much avail. Consistent and vigorous action will be

necessary for some years to come if sleeping sickness is to be stamped out of the country.

THE United States not only produced 96.6 per cent. of all the salt consumed within its borders in 1907, but exported nearly 62,000,000 pounds, valued at more than a quarter of a million of dollars, according to W. C. Phalen, whose report on the salt and bromide industry of this country for the last calendar year has just been published by the U. S. Geological Survey. The salt production of the United States in 1907 amounted to 29,704,128 barrels of 280 pounds, valued at $7,439,551—an increase of 1,531,748 barrels in quantity and of $781,201 in value over the output in 1906. The average net value of the product in 1907 was $1.79 cents per short ton, as against $1.69 per ton, in 1906, an increase for 1907 of 10 cents per ton. In both quantity and value of output the United States stands at the head of the salt-producing countries of the world. In quantity the United Kingdom, the German Empire, and France rank next, in the order given, although the value of both the German and the French output exceeds that of the United Kingdom.

A TOTAL output far in excess of that of any previous year or any other country, an unparalleled accumulation of stocks, and high prices for oil of all grades characterized the petroleum industry of the United States in 1907, according to David T. Day, of the United States Geological Survey. The total production of petroleum in this country in 1907 amounted to 166,095,335 barrels, an increase of 39,601,399 barrels over the production of 1906, the increase being greater than the total product of petroleum in any year up to 1889. The total value increased from $92,444,735 in 1906 to $120,106,749 in 1907. The average price decreased slightly, from $0.731 per barrel in 1906 to $0.723 in 1907.

THE London *Times* states that long before the flight of his fourth airship Count Zeppelin had been laying his plans for the construction of his fifth balloon. Ten or twelve weeks ago he entrusted Messrs. C. G. Spencer and Co., the well-known manufacturers and aeronauts of Highbury, with the task of making the balloon fabric. The work is in full progress in the works at Highbury. In the factory a number of girls are engaged in preparing the goldbeaters' skin from which the Zeppelin balloon No. 5 is to be made. The envelope will be composed of six layers of the skin, and by a process known only to the firm the skins are so joined together that no seams are visible, and the finished fabric combines extreme lightness with an extraordinary degree of toughness. Mr. Spencer said that the cells, or gas holders, of No. 5 balloon were being built like a very large drum, and were divided into 15 sections, each being self-contained. The holding capacity of these would be 40,000 cubic feet, so that the whole balloon —600,000 feet—would be considerably larger than that of No. 4. There would be sufficient room in the building for the inflation of each section separately. The sections would then be packed carefully and sent to Germany to be fitted into the rigid framework of Count Zeppelin's airship. Mr. Spencer said that this goldbeaters' skin is the strongest material for its weight that could be found. Hitherto Count Zeppelin had relied, he said, upon an indiarubber-covered fabric, but though this is cheaper it is three or four times heavier. It is estimated that the skins of about 600,000 cattle will be required before the work is finished. The firm expects to finish the fabric in about a fortnight.

ACCORDING to a report recently issued, the total number of visits recorded as having been made by the public to the Natural History Museum (London) during the year 1907 was 497,437, as compared with 472,557 in 1906—an increase of 24,880. The number of visits on Sunday afternoons was 66,367, as against 61,151 in the previous year. The average daily attendance for all open days was 1,370.3; for week-days only, 1,386; and for Sunday afternoons, 1,276.3. The total number of gifts received during the year by the several departments of the museum was 2,105, as compared with 2,057 in 1906, among the donors being the Egyptian government (an important series of fishes from the Nile); the Prince of

Wales (the skeleton of an Indian elephant from Mysore); the Hon. W. Rothschild (a mounted specimen of a bull of the Alaskan elk); and Mr. Boyd Alexander, in the name of the Alexander-Gosling expedition (the skin and skull of a male Okapi, and portions of the skin of two other individuals of the same species, obtained by him during his recent journey from Nigeria to the Nile).

As a result of a recent conference between representatives of the War Department and the Forest Service, looking toward the practise of forestry on timberlands on military reservations, the Forest Service has received requests from Fort Mead, South Dakota, and Fort Leavenworth, Kansas, for an examination of the forests at those posts. The service will suggest a plan of management in each of these instances, as well as for other posts from which similar requests are received. Military reservations which have been examined and reported upon in the past are those at West Point, New York; Fort Wingate, New Mexico; the Rock Island Arsenal, Illinois, and the Picatinny Arsenal, New Jersey. The forest at West Point, for which the Forest Service made a working plan in 1903, is supplying the post with part of the needed cordwood, lumber, hurdle poles, tan bark and other forest products. Similar plans are in preparation for the forests of Rock Island and Picatinny Arsenals.

The results of the French scientific mission to the Congo for the study of the sleeping sickness, recounted in the *Dépêche Coloniale Illustrée,* are abstracted in the London *Times,* according to which that mission, under the charge of Dr. Gustave Martin, did not get seriously to work before June of last year. It has had to struggle against the inertia and often the ill-will of the natives. In the region of the Upper Ubangi and the basin of the Gribingi and the Shari they found only isolated cases. On the other hand, in the immense country of the Middle Congo, the Sanga, and the Ubangi up to the sea there are no points where the plague has not exercised its ravages, devastating entire villages. The members of the mission have personally visited the caravan routes from Brazzaville to Loango up to Buanza, Madingu, and the mountainous region between the copper zone of Minduli and the former political post of Manganga, the Upper Alima, the Lower Sanga, part of the valley of the Congo, and the Upper Ubangi as far as Fort de Possel and Bessu. As a general result of their observations it is evident, says the present report, that no diagnosis of the sleeping sickness is certain without the revelation of the presence in the organism of the trypanosome. The best microscopic method of discovering the presence of the microbe is a problem which has absorbed the attention of the mission. By the mere microscopic examination of the blood 258 natives were found harboring the microbe and twenty Europeans were discovered to be infected. The director of the laboratory department of the Pasteur Institute, M. Mesnil, says, indeed, in his report on the preliminary studies of the French mission, that minute examination of the blood of all Europeans who have spent some time in the tsetse zones is an operation that ought not to be neglected. No vaccine nor serum avails to cure the sleeping sickness. The future belongs to chemical therapeutics, and the atoxyl treatment is the only one which, according to this authority, gives generally good results. This remedy was first employed by Mr. Thomas in 1905 at the Liverpool School of Tropical Medicine, although the action of arsenical compounds in animal trypanosomiases had already been recognized by numerous investigators. At the same time certain inconveniences, already noted at Liverpool, in the use of atoxyl alone are confirmed by the French mission. The French mission, aided by the government and the geographical societies, proposes a certain number of practical preventive measures. A sum of 250,000f. is now being solicited to continue the work already begun and to place France on an equality with the other powers in the struggle against this terrible plague.

Nature quotes from the *Comptes rendus* of the Paris Academy of Sciences for June 29 the report of the committee appointed to consider the distribution of the Bonaparte fund

for 1908. The committee has considered 107 applications for assistance from this research fund. Some of these, it is mentioned, do not comply with the conditions laid down by the founder, Prince Roland Bonaparte, and others are for work entirely outside the field of the Academy of Sciences. The committee excludes also demands for assistance in researches in medicine, surgery and general biology, since the funds of the *Caisse des Recherches scientifiques* are exclusively reserved for biological studies. Ten grants are recommended as follows: (1) 2,000 francs to L. Blaringhem for a continuation of his important studies on the variation of species and the experimental methods for the creation of new species of plants; (2) 2,000 francs to Dr. Billard to enable him to pursue his studies on the hydroids; (3) 2,000 francs to Dr. Estanave to furnish him with a means of continuing his researches on direct vision projection in relief, with special reference to radiography; (4) 2,500 francs to MM. Fabry and Buisson for a continuation of their work on the establishment of a system of standard wave-lengths. The grant is to be applied to the purchase of a plane grating, a metal concave mirror of large diameter, and two plane mirrors required for a study of the differences between the lines of the solar spectrum and those of the electric arc; (5) 5,000 francs to M. Gonnessiat for the purchase of astronomical intruments for the observatory of Algiers; (6) 2,000 francs to Dr. Loisel for the continuation of his actinometric observations at the Observatory of Juvisy; (7) 2,000 francs to M. Dongier for the establishment of apparatus for the simultaneous study of the rainfall and atmospheric potential; (8) 2,500 francs to M. Perot for the spectroscopic study of the light from the sun by interferential methods; (9) 2,000 francs to M. Matignon for the determination of specific heats at high temperatures; (10) 3,000 francs to P. Colin for the publication of a map of South Imerina. These recommendations were adopted by the academy.

A COMMISSION, appointed by the crown to investigate the condition of Ireland's forests and to suggest measures for bettering it, has just made public its report. The commission became convinced that there was imperative need for afforestation on a large scale, that the time had come when the "let alone" doctrine applied to the woods could no longer be endured. The commission outlines and vigorously urges the adoption of a large scheme for the state to plant about 700,000 acres with forest trees. This, with the 300,000 acres of existing forest, would give Ireland 1,000,000 acres of forest land, an area which the commission considers essential for the agricultural and industrial requirements of the country. About 20,000 acres of this would be purchased by the state in mountainous and rough regions and managed as state forest, while 500,000 acres, chiefly in small blocks, would be planted by the state, but managed by private owners or by county councils. The facts that under the Land Purchase Acts much woodland formerly held in large blocks is being sold in small parcels and lumbered, and that there is now opportunity for the government to acquire woods and land suitable for forests, make it specially urgent for the state to take immediate action. To show that such a scheme of land acquisition and planting is not impracticable, the Commission cites the case of Denmark, an agricultural country half the size of Ireland, which, since 1881, has increased her forests by 175,000 acres. Another case is that of little Belgium, which, in spite of her dense agricultural and industrial population and already large forests, has added 70,000 acres to her forests in the last twenty-five years. Though Ireland is particularly suited in soil and climate for the growth of forests, and some of her area is much better adapted for forests than agricultural crops, yet only 306,000 acres, or one and one half per cent. of her total area is forested.

UNIVERSITY AND EDUCATIONAL NEWS

AN anonymous gift of $100,000 has been made to the Vienna Academy of Sciences for the establishment of a "Radium Institute" in connection with the new physical laboratories of the University of Vienna.

It is announced that hereafter women who are subjects of the German empire will be admitted to the universities on the same footing as men. Women of other countries will require the permission of the minister of public instruction for matriculation.

The governors of University College, Bristol, have approved the draft charter for establishing a University of Bristol.

According to the daily papers, the salaries paid to instructors and professors at the University of Chicago will be increased by about twenty-five per cent. An official statement of the changes in the salaries will doubtless be made shortly.

Jay William Hudson, Ph.D. (Harvard), has been appointed assistant professor of philosophy in the University of Missouri.

Alfred Edward Taylor, M.A., Frothingham professor of philosophy in McGill University, has been appointed professor of moral philosophy in the University of St. Andrews, in succession to Professor Bosanquet.

Dr. Henry Alexander Miers, F.R.S., fellow of Magdalen College, Oxford, and Waynflete professor of mineralogy in Oxford University, has been appointed principal of the University of London, from October 1, upon the resignation of Sir Arthur W. Rücker.

At the University of Manchester Dr. J. E. Petavel, F.R.S., has been elected professor of engineering; Mr. T. G. B. Osbern, lecturer in economic botany; Mr. C. H. Lander, lecturer in engineering drawing; and Dr. F. H. J. A. Lamb, senior demonstrator in physiology.

THE COLLEGE OF ENGINEERING OF THE UNIVERSITY OF ILLINOIS

The college announces the following new appointments for the college year beginning September 16, 1908:

F. D. Crawshaw, B.S. in electrical engineering, Worcester Polytechnic Institute, '96, who has served as head of the manual training department of the Central High School, Minneapolis, Minn.; as first assistant, manual arts department, Bradley Polytechnic Institute, and as principal of the Franklin School, Peoria, Ill., to be assistant dean of the College of Engineering.

Frank B. Sanborn, B.S. Dartmouth, '87, C.E. Dartmouth, '89, M.S. Harvard, '98; for nine years past professor in charge of the department of civil engineering, Tufts College; has been granted leave of absence for one year by that institution and during this time will act as assistant professor of civil engineering with the University of Illinois, doing work not otherwise provided for during the prospective temporary absence on leave of Professor I. O. Baker.

Shelby S. Roberts, B.S. Rose Polytechnic Institute, '98, C.E. Rose, '07; for the past ten years engaged in railway work, chiefly with the St. Louis, Peoria & Northern Railway, the Louisville & Nashville, and the Illinois Central, has been appointed assistant professor of railway civil engineering. Mr. Roberts will give his entire attention to instructional and research work with reference to railway track construction and maintenance and with reference to railway signaling.

William F. Schulz, a graduate of the Baltimore Polytechnic Institute in 1890, an honor man at Johns Hopkins University, '93, bachelor of science in electrical engineering, University of Illinois, '00, Ph.D. Johns Hopkins University, '08. For five years assistant and instructor in physics at the University of Illinois, has been appointed assistant professor of physics.

Kenneth G. Smith, A.B. University of Chicago, '96, B.S. in mechanical engineering, University of Illinois, '05; for three years with the Kerr Turbine Company, has been appointed to have charge of the engineering experiment station extension work, with the rank of assistant professor of mechanical engineering.

A. St. J. Williamson, University of Illinois, B.S. in mechanical engineering, '98, M.E. '02, and for the past seven years engaged in railway work, chiefly with the Mexican Central Railway, has been appointed instructor in railway mechanical engineering.

C. F. Kelley, A.B. Harvard University, '06, a student with De Camp and other noted artists, has been appointed instructor in architecture.

C. C. Albright, B.S. Purdue University, '03,

C.E. '08, and for the past five years engaged in railway work, has been appointed instructor in civil engineering.

A. R. Lord, B.S. in civil engineering, University of Maine, '07, and for the past year instructor in civil engineering of the same institution, has been appointed instructor in general engineering drawing.

F. W. Doolittle, a graduate of Lenox College, A.B. Princeton, a graduate in civil engineering, University of Colorado, '07, has been appointed instructor in theoretical and applied mechanics.

J. G. Kemp, A.B. University of Illinois, '06, and for the past two years assistant in physics at Purdue University, has been appointed assistant in physics.

E. C. Converse, A.B. University of Illinois, '04, and for the past four years a teacher in the public high schools, has been appointed assistant in physics on part time.

A. M. Elam, B.S. in mechanical and electrical engineering, State University of Kentucky, '08, has been appointed assistant in general engineering drawing.

Lewis McDonald, B.A. and B.S. in civil engineering, University of Illinois, '08, has been appointed assistant in civil engineering.

The facts set forth by the preceding statement emphasize the organic growth of the school of railway engineering and administration which was established two years ago by the University of Illinois. This school stands midway between the college of engineering and the department of economics. Its director is the dean of the college of engineering. Its organization within the college of engineering at present consists of an associate professor of railway engineering, in general charge, and especially concerned with the problems of railway equipment; an assistant professor of civil engineering, especially concerned with problems of the track; an instructor in railway mechanical engineering, especially concerned with locomotive performance and train resistance; and an associate in railway engineering, especially concerned with the specialized problems of electrical traction. Its organization within the department of economics consists of a professor of railway administration and an instructor in railway accounting.

DISCUSSION AND CORRESPONDENCE

WILD JAMAICA COTTON

TO THE EDITOR OF SCIENCE: With reference to the interesting letters of Messrs. Colville, Britton and Cook in SCIENCE of April 24, I venture to write to mention that I have grown several samples of cotton seed from Jamaica, kindly sent by the Agricultural Department. One of the varieties grown appears to be identical with the one under reference except in the case of the flowers, which in my specimen were all yellow or pale yellow. The identity of the two varieties can easily be proved or disapproved owing to the fact that the bracteoles of my plants have only two to four teeth, while most varieties with which it could possibly be confounded have many more. It is quite distinct from *G. punctatum* Sch. & Thon. as are also many plants stated by Watt to belong to this species, *e. g.*, "the Hindi weed of Egypt"; it is, however, apparently identical with the specimen figured by him as *G. punctatum* var. *Jamaica*.

With reference to the main point raised in correspondence viz.: the explanation of a mixture of naked and fuzzy seeds. The seeds of my cotton were all naked, but seeds giving rise on sowing to exactly similar plants, and all bearing either grayish or brown, or green fuzz, were received from Trinidad, Nicaragua and neighboring regions. This supports the statement made by Mr. Cook, that the variation in the fuzz does not necessarily imply hybridization. Further evidence on this point is that these varieties come true to seed.

I have grown other varieties, however, which gave a mixed product similar to that in question. Owing to poor germination consequent on poor monsoons, I failed (while in India) to obtain very definitive information as to the numerical ratio in which this character in such cases passes from generation to generation, but in one case, at least (that of a cotton from Bagdad), it was found that both naked and fuzzy seeds picked from the same plant gave rise to plants bearing both

kinds of seeds. Now, Mr. Balls[1] and myself[2] have independently proved that fuzziness of the seed is dominant when crossing occurs between a naked and fuzzy seeded variety. If, therefore, the mixed character of the seed is due to its having been borne by hybrid plants, we should expect segregation of the characters and, on sowing, the naked character (recessive) having once appeared should come true to seed. As stated above, this did not, in the case noted, occur and the mixed character of the offspring is therefore apparently not due to the hybrid character of the parent.

So far as experiment has yet gone the nakedness or fuzziness of the seed appears to be subject to fluctuations that are unusually large even in this genus of large fluctuations. I have grown many varieties of cotton that differ only in this characteristic and come perfectly true to seed in respect of it and have further found that the fuzziness of a variety is decreased by growth under certain conditions.[3]

F. Fletcher
School of Agriculture,
Giza, Egypt

QUOTATIONS

AS TO UNIVERSITY ADMINISTRATION

The Popular Science Monthly has some sharp things to say editorially in its July issue in regard to the administration of American universities, with special reference to recent events at Syracuse, Cincinnati and in Oklahoma. There is not a little justice in the contention that whereas "elsewhere throughout the world the university is a republic of scholars administered by them," in this country it is "a business corporation." The complaint is not new, and it is being made more and more frequently of late. The editor goes on to say:

"The ultimate control is lodged in a board of absentee trustees, whose chief duty is the election of a president. The qualifications most regarded in the president are the ability to get money for the institution and a good presence at public functions; but he is expected to "run" the university. The professors and instructors are employed "at the pleasure of the trustees," and so long as the president maintains his position, this means at his pleasure. Advances in salary or position, appropriations for apparatus, etc., are subject to the same pleasure. In larger institutions the department-store system naturally grows up. Deans and heads of departments are responsible to the president, and their subordinates are responsible to them."

It is fair to say that the American ideal of efficiency is responsible for a system which has its virtues, and is unfortunate mainly because it comes into conflict with another and even higher American ideal, the ideal of democracy. In a great business organized under keen competitive conditions there is as little room for democracy as in the army. All other considerations must yield to that special efficiency which belongs to strong autocratic control.

But if there is any place where this system does not belong, it is the university. Here there is no mad scramble for wealth, no competitor to crush, no secret tactics to follow. Culture should be made not "to hum," but to blossom sweetly. More important than great gifts or new buildings or business-like management is the maintenance of academic freedom and of the dignity and self-respect of the faculty. The professor is, or ought to be, more than a mere employe, hired for a certain "job." And the president is, or ought to be, both more and less than a mere superintendent, to hire and discharge and make a good showing with his yearly reports. No single thing has done more harm to higher education in America during the past quarter-century than the steady aggrandizement of the presidential office and the modeling of university administration upon the methods and ideals of the factory and the department store.

That it does not in all cases work badly is due simply to the fact that the men are better

[1] "Year-book of the Khedivial Agricultural Society," Cairo, 1906.

[2] "Mendelian Heredity in Cotton," *Journal of Agricultural Science*, Vol. II., Part III.

[3] "The Cotton Plant," *Nature*, Vol. 77, No. 1994.

than the system. As *The Popular Science Monthly* says: "In a great university, such as Harvard, courtesy and consideration do not fail. In the smaller colleges, there is the spirit of the family. So long as the best men are found at our colleges and universities, it may not matter greatly under what system of academic government they live. But there is real danger that the existing system may prove repulsive to men of the highest intelligence and character, and that mediocrity and time-serving may be developed, where we need the most vigorous ability and independence." It was the older American idea that the president of a college was simply primus inter pares. To-day there is as wide a gulf between him and his faculty as between a superintendent of city schools and the grade teachers, and however the change may better business management, it does not attract strong men to the profession of teaching, nor does it foster a vigorous intellectual life in the universities. And occasionally a gross and tyrannical abuse of authority reminds the world how far America is behind Germany in the freedom of its university life.—*Springfield Republican.*

SCIENTIFIC BOOKS

The Labyrinth of Animals. By ALBERT A. GRAY. Vol. II. London, J. A. Churchill. 1908.

The first volume of Dr. Gray's extensive stereo-photographic studies of the vertebrate labyrinth ha been reviewed in SCIENCE.

The second volume is fully up to the standard of the first volume, and is a storehouse of interesting and valuable information. The author, in a prefatory note to Vol. II., states that he is indebted to the Carnegie Trust for their liberal generosity in assisting him in the publication of this volume. We think the volume well worthy the support.

As in the first volume there is a series of stereoscopic photographs, giving magnified views of the labyrinths of the various animals studied. Brief descriptions and summaries accompany these photographs.

The volume begins with the continuation of the study of the rodent labyrinth. The labyrinth of the capybara is interesting, in that it presents the most extreme example of the sharp-pointed type of cochlea yet described.

The labyrinth of the insectivora is next considered. "This organ shows evidence of more ancient characteristics than that of any other order of mammals with the exceptions of the monotremata, sirenia, cetacea and a few of the polyprotodont marsupials."

In the labyrinth of the cetacea and sirenia, the cochlea is of a "very primitive type." The appearance of the labyrinth lends little support to the view that the sirenia and cetacea are closely related to the ungulates or to the edentata. The ankylosis of the cervical vertebræ, which is so marked a feature in the anatomy of the cetacea, and the consequent limited movement of the head upon the trunk, are associated with marked modifications in the vestibules and canals. The semicircular canal portion of the labyrinth is very small as compared with the cochlear portion.

The marsupialian labyrinth is next considered. "While there is no doubt that the marsupials left the main stem of mammalian descent at a much earlier period than most of the orders, yet, so far as the labyrinth is concerned, they have developed along parallel lines to such an extent that the organ must be considered almost as far advanced as in some of these orders."

The only example of the monotreme labyrinth studied by Dr. Gray is that of the duck-billed platypus. "In appearance it may be said to stand midway between the labyrinth of the reptiles and that of the eutherian mammals."

The study of the labyrinth of mammals is concluded by a brief study of the venous system of the labyrinth.

The labyrinth of birds is next taken up. The comparative anatomy of the avian labyrinth has been less studied than that of other divisions of the vertebrates. Thus Gray's contributions to the subject are of special value. The labyrinth of birds bears resemblances to that of the alligator on the one hand and that of the monotremes on the other.

In general, in birds the vestibule is very small, while in reptiles it is the largest part of the labyrinth. In some respects the canals in the avian labyrinth show greater resemblance to those in the mammalian labyrinth than to those in the majority of reptiles.

The book is concluded by a brief description of the labyrinths of reptiles and amphibia. Dr. Gray points out that the typical reptilian labyrinth of the present time is by no means so similar to that of birds, as many anatomists seem to think. The labyrinth of the alligator is very different from the typical reptilian organ. In reptiles the cochlea is relatively small, and is drawn out in the form of a cone, except in the teguixin and the alligator, where it has more of a tube shape. The vestibule is the bulkiest portion of the labyrinth, and contains a well-developed otolith apparatus. The canals are distinguished from those of birds, mammals and amphibians by their angularity and comparative straightness of outline. The horizontal canal, however, has a curved outline as in other divisions of the vertebrates. The canals are not set in planes at right angles to one another, but are frequently in planes which are parallel to one another, or at angles of forty-five degrees. This is of importance in view of theories which have been advanced as to the functions of the canals.

The description of the labyrinth of the amphibians is limited to two examples, both belonging to the anura. The author states that since the organ varies considerably in different species a much larger amount of material would be required to give an even fairly complete description of the labyrinth of the amphibians. The descriptions given of the labyrinths of the giant toad and the tigrine frog are interesting for the sake of comparison with those of higher forms.

As in the preceding volume, very valuable tables of measurements of the various labyrinths studied are given.

Dr. Gray is to be congratulated upon the important contribution which he has made to this valuable field of comparative anatomy.

C. R. B.

A Text-Book of Physiological Chemistry. By Olof Hammarsten. Translation from the Sixth German Edition, by John A. Mandel. Fifth Edition. New York, John Wiley and Sons. 1908. Pp. 845.

Professor Hammarsten's "Physiological Chemistry" continues, in its successive editions, to rank as the most successful and reliable of the current text-books, if it is not also the most popular among them. One gains a good impression of the rapid advances which chemical physiology has experienced in recent years by comparing the first German edition of 1890—a book of 400 pages—with the present translation of its latest successor. Familiar defects of text-books on progressive "laboratory sciences" have consisted in the failure to keep abreast of the advances in knowledge and in the tendency to present the subject—physiology in particular—in a cut-and-dried, dogmatic fashion. One can only admire the industry of Professor Hammarsten in maintaining a thoroughly up-to-date record. In contrast with several of the American and German books in the same field, his volume shows both range and perspective in a degree which is attributable to the author's long experience and broad scholarship. But in addition to all this, the treatment is peculiarly *suggestive,* so that the reading of any chapter will bring to even the younger student some appreciation of the present evolutionary stage of physiological chemistry and of the problems which present themselves on all sides. A review of scientific evidence may not furnish an ideal compendium for "preparing for examinations." It is, however, eminently superior to a dogmatic text in affording an appreciation of the way in which physiology develops.

The successive editions of Hammarsten's book seem to the reviewer to embody a gradually improved critique in the elimination of accumulated data of uncertain value. Furthermore, it is encouraging to find in a foreign compilation some adequate recognition for the work of American biochemical investigators.

Hammarsten's text-book can not be said to

present the novelty of viewpoint which is peculiar to parts of books such as those by Bunge and Abderhalden. The element of propaganda is nowhere present; but as an orderly arranged storehouse of contributions to the literature it remains unsurpassed. Many of us have learned to depend upon Hammarsten's "Physiological Chemistry" as a reliable help of almost cyclopædic comprehensiveness. Both the author, on the eve of his retirement from active teaching, and the translator have rendered a further useful and creditable service.

LAFAYETTE B. MENDEL
YALE UNIVERSITY

Devonic Fishes of the New York Formations. By CHARLES R. EASTMAN. New York State Museum, Memoir 10. Albany, New York State Education Department. 1907. Pp. 1–235, plates 1–15.

This is unquestionably the most important contribution to the study of American fossil fishes since the publication of Newberry's classic monograph nearly two decades ago.[1] It embodies the results of years of painstaking research; is carefully elaborated, beautifully illustrated and, like everything else from Dr. Eastman's pen, clearly and interestingly written.

It is, of course, out of the question to attempt here a discussion of the many novel facts and interpretations in which the memoir abounds. We may only touch here and there upon some point of special importance.

One of the valuable features of the memoir consists in the large number of new forms and new localities that are put on record. The most noteworthy among these, perhaps, is that of the discovery in America of the genus *Asterolepis*. This is represented by only a single armor plate, unfortunately, but the figures and description leave no doubt that the specimen is an *Asterolepis*. It comes from a lower Devonic horizon (Chapman sandstone of Maine)—a circumstance of high importance; for inasmuch as all the European species[2] of *Asterolepis* have come from the Upper Devonic, the present specimen carries the history of the genus farther back in time than hitherto known. It proves, too, that the organisms of the antiarchan style of structure attained high specialization as early as the Lower Devonic, when they were already represented by three genera, *Asterolepis, Pterichthys* and *Microbrachius,* thus making almost positive the indication that the ancestors of the Antiarcha may one day be discovered as far back as the Upper or Middle Siluric.

There are also described a new species of *Ptyctodus,* one of *Machæracanthus,* one of *Cladodus:* the last, represented by a tooth from the Middle Devonic of Ohio which is declared to represent the oldest cladodont shark yet known (p. 62). Judging by its size one must infer that the cladodonts of that early day had already taken on goodly proportions.

Among arthrodiran "fishes" an interesting small dinichthyid is described, *Dinichthys dolichocephalus;* a new *Glyptaspis,* and a new genus *Protitanichthys.* In connection with this new genus, the type of which (a cranial shield) I have had the opportunity of examining, thanks to the kindness of Dr. Eastman, I regret that I can not put myself in accord with the interpretation given by the author. Dr. Eastman regards this form as a primitive *Titanichthys*—chiefly because the head shield has a pineal element that is broader than long. But this fact, in the reviewer's opinion, is rather inadequate proof that the species is a Titan. *Titanichthys* is not the only Arthrodire with an abbreviated pineal, Dr. A. S. Woodward having long since shown the presence of such a pineal in *Phlyctænaspis.*[3] And, moreover, a careful study of the type specimen shows the pineal to be really elongated as in typical coccosteids. What Dr. Eastman figures as the posterior suture of the abbreviated pineal, I am convinced, is

[1] "The Paleozoic Fishes of North America," Monograph U. S. Geol. Survey, XVI., 1889.

[2] With the reservation indicated by Eastman (p. 40, foot-note), in favor of the obscure fragments described by Pander from the Siluric of the Baltic provinces.

[3] *Geological Magazine,* Vol. IX., 1892, pl. i, fig. 8.

but a transverse flexure across the middle of that plate proper. But even apart from the question of the shape of the pineal element, the genus *Protitanichthys* is obviously founded on doubtful grounds. As Dr. Eastman himself points out (pp. 144, 145), it is extremely probable that this cranial shield belongs to a true *Coccosteus,* perhaps to *C. occidentalis* or to the so-called *Liognathus spatulatus,* both of which are known only from single elements found in the same formation (Delaware limestone, Delaware, Ohio). In view of these considerations it appears to me that the name *Protitanichthys* itself is objectionable. The prefix *Pro* in generic names ought to be rigidly restricted to such cases only where the evidence for ancestral relationship amounts to practical certainty, as, for instance, in the phylogenetic series of the horses or the camels.

In regard to *Acantholepis,* also, we are forced to dissent from Dr. Eastman's interpretation. Newberry and others have shown that the objects so named are dermal defenses of some indeterminable Arthrodire or Ostracophore. Now Dr. Eastman rejects this interpretation and advances the view, upon very slender evidence, that they are "dermal defenses of Chimæroids, probably dorsal finspines" (p. 78). He speaks of these spines as having exserted and inserted moieties, though admitting (p. 79) that the inserted part has never been observed.

A few minor slips have crept into the text —a circumstance not surprising when one considers the mass of detail dealt with. Thus it is stated that no dinichthyid is known to have symphyseal denticles (p. 126), when in 1906 the reviewer published two figures of a mandible belonging to the Newberry collection which clearly displays some ten such denticles.[4]

On one or two points we could wish that the figures had been fuller. For instance, a description is given of what Dr. Eastman interprets as the parasphenoid of *Macropetalichthys.* When one considers that the structure so named by our author has never been adequately described; that among those having intimate first-hand acquaintance with the specimens some go the length of denying that any structure homologizable with a parasphenoid at all exists in *Macropetalichthys,* or indeed in any arthrognath; one wishes that this debatable element had been carefully illustrated, so that whoever wished might judge whether this be a parasphenoid or not. One also could wish that the dentition of that primitive form *Dinichthys halmodeus* had been figured so that we could have arrived at a clear concept of the peculiarities of these interesting structures.

And lastly, this review were inadequate indeed, did we not touch upon Dr. Eastman's views on the relationships of the *Arthrodira* —a group upon which he has bestowed considerable time and effort during the past few years and which occupies no less than a quarter (68 pages) of the present memoir. Indeed, his view of the affinity of the Arthrodira is the veritable *Leitmotif* which runs through his entire discussion of the group.

This theory may be briefly stated as follows: a Paleozoic dipnoan gave off two lateral branches of lung fishes. One of these flourished through several geological periods, giving rise to *Dipterus, Ctenodus, Uronemus* and the like, finally becoming extinct; the second branch, constituted the stock of the Arthrodires, evolved a galaxy of forms, only to become extinguished at the close of the Devonic. The central stock of primitive ceratodonts, on the other hand, continued essentially unmodified through all later geological periods and is represented at the present day by the existing lung-fishes.

Hence Dr. Eastman upholds two distinct theses: (1) that a ceratodont, not a dipterine, exemplifies most nearly the primitive dipnoan; and, (2) that the Arthrodira are specialized offshoots of this primitive ceratodont.

The first of these theses, although contravening the widely accepted view elaborated by Dollo and others, our author does not treat at any length in this memoir and we need not, therefore, go into it.[5] As for the second, the

[4] *Mem. Amer. Mus. Nat. Hist.*, IX., 1906, p. 118, fig. 11, and p. 149, fig. 25 *C.*

[5] For a critique of Dr. Eastman's views on this

reviewer has already in part expressed his opinion[6] and Dr. Eastman's renewed arguments have not led him to alter his point of view.

The central argument against Dr. Eastman's theory of the dipnoan affinity of the Arthrodira seems to the reviewer to be that he lays too much stress on a single character —the resemblance of the crushing dentition of the ceratodonts to that of *Mylostoma* among arthrodires. This resemblance he interprets as an homology and makes it one of the cardinal arguments for relationship. But why may not this partial resemblance in dentition be a case of parallelism, of adaptation to similar food, in two widely different groups? —especially so in view of the wide differences between arthrodires and dipnoans in other regards, and because of the frequent occurrence among fishes of adaptations to a similar hard diet. It seems to the reviewer that a close examination of Dr. Eastman's argument for the homology of the ceratodont and arthrodiran dentitions, especially the exposition on pages 150–151, will hardly carry conviction to the mind of the critical reader.

But the establishment of homology between ceratodont and arthrodiran dentitions is the crucial point in Dr. Eastman's theory. Reject this central argument as not proved or, if you please, as *sub judice,* and little evidence remains, at least in the reviewer's opinion, to support the thesis of a genetic affinity between arthrodires and dipnoans. Some of the adduced evidence must, in fact, be ruled out of court as not material to the present case, for instance the question of the shape of the caudal fin[7] or of the homology of certain skeletal elements.

Furthermore, as Professor Dean has recently urged, there are certain absolutely irreconcilable differences between arthrodires and dipnoans; for instance, the presence in all arthrodires of a complicated dorsal and ventral body-armor constructed on one plan and with complicated neck joints, and its absence in all dipnoans.

And again, the characters linking the arthrodires with the Ostracophores to which writers have again and again called attention within the past half century, are surely not dipnoan.

These are only some of the broader criticisms against Dr. Eastman's views on the affinity of the arthrodires. Did space permit, we might profitably examine certain of the subsidiary hypotheses and conclusions and point out minor difficulties and discrepancies which weigh against Dr. Eastman's main thesis. But enough has been said, we believe, to indicate some of the chief grounds for dissenting from our author's view that the Arthrodira are specialized dipnoans.

L. HUSSAKOF
AMERICAN MUSEUM OF NATURAL HISTORY

Variations and Genetic Relationships of the Garter Snakes. By ALEXANDER G. RUTHVEN. United States National Museum, Bulletin 61, pp. 201. 1908.

In these days of minute analysis on the part of systematic zoologists, an acute and exact study of variation with a synthetic purpose comes as rest to the weary.

The courage displayed by Dr. Ruthven in giving reasons for his scheme of genetic relationships in this impracticable group can be best valued by other herpetologists who have ventured on the same task and have been carefully secretive as to how they did it. As one of these I may be privileged to both praise and criticize this excellent paper.

Nothing but good can be said of the method adopted by the author in carefully estimating the value of the characters commonly held to be specific in snakes, and of the painstaking care with which it has been followed to the end. It is an ingenious bit of demonstration, and one easily verifiable, which shows that reductions in the number of rows of dorsal scales as girth of body decreases in the in-

[6] For subject see a review by Professor Bashford Dean in SCIENCE, July 12, 1907, p. 48.

[6] *Mem. Amer. Mus. Nat. Hist.*, IX., 1906, pp. 126–128.

[7] For, granted even that *Coccosteus* had a diphycercal tail, and that fact does not alter the balance of evidence, since a diphycercal tail is not an exclusively dipnoan character.

dividual snake, are brought about always by the dropping of certain definite rows, and are not promiscuous, and this observation leads on to the almost equally certain conclusion that specific variation in the scale rows follows the same sequence as in the case of individuals, and is correlated with girth of body. Outside of such sequence variation so rarely occurs that it is negligible. So also with the labial scuta, certain of which are present, absent or fused, in dependence upon head-length.

These results are of much interest and value, and will become more so with increasing knowledge of the processes which make up the so-called "laws of growth." But—and here criticism must take a hand—however surely the chapter on variation establishes these and other novel facts, the reviewer is not able to see that the proposition laid down by Dr. Ruthven as a guide to his phylogenetic lines of parallel development necessarily follows from them. The proposition in brief is that *Thamnophis* started out with the maximum number of dorsal rows known in the genus, and that the forms resulting from geographical extension are for the most part consequent on dwarfing, due to unfavorable environment—the whole course of species formation in the group being one of reduction, and the maximum of size being assumed to be *T. megalops,* of the Mexican plateau, with an occasional twenty-three rows. This is a necessary step to the author's final conclusion as to the original home of *Thamnophis,* but it is by no means certain that *megalops* in the average is really larger than *sirtalis* or *parietalis* of the north, and examples of the questionable form known as *biscutata,* from Oregon, are now and then found which also have twenty-three rows.

Dwarfing has undoubtedly been a factor in the formation of some species, as notably *butleri* and *leptocephalus,* but the evidence is not complete that it has been general. Indeed the fundamental postulate of the theory has more strain put upon it than it can bear, for in the light of what is known as to the relative abundance of garter snakes in different portions of their range, and of their habits, it is not easy to admit that all conditions encountered by them beyond the Sonoran habitat of *megalops,* must be regarded as unfavorable.

If variability in dorsal scales is related to size, and has become definitely limited as a physiological function of certain rows, it is altogether possible, and to the reviewer it seems probable, that the process of differentiation into species has been much more complex than the scheme so ingeniously developed by Dr. Ruthven, and that loss by dwarfing, and gain, perhaps by reversion, have played their respective parts over and again as species have adapted themselves during their migrations to unfavorable or favorable environments.

This leads to the one of Dr. Ruthven's conclusions which is most open to question, in that his four lines of descent in *Thamnophis* are traced back to northern Mexico as the center of origin of the genus.

As presented here there is incompleteness in the theory, for it requires the existing forms of garter snake to be left there, just as they are, in a sort of cul de sac, from which there is no further phyletic outlet. There is no guide possible, even to speculation, as to a common ancestral form, or as to the source from which the genus was derived.

Zoological geographers will be slow to believe that a group so largely dependent upon water is likely to have originated in an arid region, concerning which there is no reason to suppose that in geologically recent times it has been less dry than now. This general consideration is of little moment in Dr. Ruthven's opinion, but certain other probabilities remain, to be less easily dismissed.

From structure and life history there seems good reason to believe that *Thamnophis* came off from *Tropidonotus,* an almost cosmopolitan genus, and one in all certainty much older. Now *Tropidonotus* is distinctly not an inhabitant of the Sonoran region, and makes no approach to it nearer than the low gulf coast of Mexico, and as an intruder up the valley of the Rio Grande. There must be significance in the absence of posterior vertebral hypapophyses in all the genera of colubrine snakes which with fair certainty

may be assigned to a Sonoran origin. Nor is there one having keeled scales, except *Pityophis,* which appears to have inherited them from *Coluber,* and exhibits them now in weakness and instability indicating that they are being got rid of. I have shown elsewhere that hypapophyses and keeled scales are probably useful in swimming, to aquatic species. In both of these respects *Thamnophis* would be an anomaly among indigenous Sonoran genera, and its possession of both structures appears to be an argument of much weight on the side of its Austroriparian origin.

In matters of detailed taxonomy little need be said, especially when one admits the sway of the personal equation among specific characters. The author does present objections of some importance to the phylogenetic schemes devised by Professor Cope and the present reviewer, but it is to be remembered that the last of these, at least, was put forward as no more than a tentative hypothesis—a *ballon d'essai* as it were—and its author has no present inclination to make defense of all its details. But it must be said that parts of Dr. Ruthven's grouping are equally inadmissible. For instance, he combines with a long known Washington and Oregon form, *leptocephalus* (*ordinoides* in his nomenclature), garter snakes from the coast region of central California, usually recognized as *elegans,* which he excludes altogether from that portion of its range. This is not a happy conclusion, in view of the fact already recorded by me (*Proc. Academy of Nat. Sciences of Phila.,* 1903, p. 290), that I removed from the oviducts of a female from Santa Cruz Co., California, which would be, and indeed is assigned by Dr. Ruthven to *leptocephalus* (*ordinoides*), thirteen young, fully developed, twelve of which in color and scutellation are typical *elegans,* as defined by Baird and Girard. The snake to which Ruthven applies the name *elegans* is a species of the mountains and high plains properly known as *vagrans.*

Again, certain specimens of *elegans* from Santa Cruz Co. and neighboring portions of California, occur that are distinguishable with difficulty from *parietalis,* which Dr. Ruthven places on a quite different line of descent.

But I cheerfully turn away from fault-finding. The paper is admirably conceived, carefully executed, is original and fearless throughout, and systematic zoology would make large measure of gain if there were hope that it might serve as a finger-post to better methods in the study of variation. Here it deserves all praise.

ARTHUR ERWIN BROWN
THE ZOOLOGICAL GARDENS,
PHILADELPHIA

SCIENTIFIC JOURNALS AND ARTICLES

The American Naturalist for July contains the following articles "A New Mendelian Ratio and Several Types of Latency," by George H. Shull; "The Leg Tendons of Insects," by C. W. Woodworth, in which the author notes that the fact that the leg tendons are cuticular invaginations, and therefore subject to replacement at each molt, has not, so far as he is aware, been published. A case of "Abnormal Incisors of *Marmota monax*" is described by Charles A. Shull, and "A Note on the Coloration of *Plethodon cinereus*" is given by Hugh D. Reed, who describes two unusually red individuals. Marian E. Hubbard gives the results of "Some Experiments on the Order of Succession of the Somites of the Chick," which show that not more than two somites can arise in front of the one first formed. Hervey W. Shimer discusses "Dwarf Faunas," concluding that the chief agency in their production is an abnormal habitat. This might come about by change in a normal habitat or by the extension of an animal's range into an unfavorable location. In "Notes and Literature" Charles A. Kofoid gives a clear and interesting résumé of "The Life History of the Eel."

The Zoological Society Bulletin for July notes the birth of a mountain goat in the Park, the first born in captivity. The parents were two of a herd of five secured by Director Hornaday in 1905, and born in May of that year. There is an account of the present status of the park showing that it ranks first in number of individuals represented in the collections, there being 4,034 animals living in the park. Under the head

of "Interesting Animal Surgery" is noted an operation for cataract performed on the Indian rhinoceros, "Mogul." A Census of American Bison gives a total of only 2,047 on January 1, of which 969 were in captivity in the United States and 41 in Canada: these figures are now different owing to the sale to Canada of the Pablo herd. As a supplement to the bulletin F. A. Lucas has an article on "The Passing of the Whale," noting that the number of whales are being rapidly lessened and that unless protective measures are taken one or two species are in danger of actual extermination.

Bird-Lore for July–August contains articles on "The Fish Hawks of Gardiner's Island," by Frank M. Chapman; "The Return of the Snowy Heron," by Herbert R. Sass; "A Little Blue Heron Rookery," by M. Harry Moore, and the fifth paper on "The Migration of Flycatchers," by W. W. Cooke. The Educational Leaflet is by Mabel Osgood Wright and devoted to the tree swallow. The report on The Audubon Societies notes steady progress, but as the result of continuous work, and the vast numbers of birds sold for "plumes" shows the necessity of further hard work.

THE LIQUEFACTION OF HELIUM[1]

In his communication to the Amsterdam Academy concerning the liquefaction of helium Professor Onnes describes in considerable detail the steps that led up to that achievement, the complicated apparatus employed, and the difficulties that had to be surmounted. The narrative conveys a vivid impression of the obstacles that have to be overcome in order to lower temperature a very few degrees in the neighborhood of the zero of absolute temperature. In spite of the most elaborate and comprehensive preparation and ample supplies of liquid hydrogen, not only was the whole apparatus, with its subsidiary arrangements, tested to its utmost capacity, but the physical energies of the professor and his assistants were well-nigh exhausted by the prolonged struggle.

The constants of helium, while showing some important points of difference, are found to agree very remarkably with the predictions made by Dewar on theoretical grounds in his presidential address to the British Association in 1902. After a correction of two tenths of a degree the boiling point of the liquid is found to be 4.5 degrees Centigrade. By exhaustion to below one centimeter, and probably below seven millimeters of pressure, the professor considers that the temperature was reduced to about 3 degrees without, however, affecting the mobility of the liquid.

The density of the liquid helium is 0.15, or about double that of liquid hydrogen; and the proportion between the density of the vapor and that of the liquid is as 1 to 11. The critical pressure is in the neighborhood of two or three atmospheres, which is relatively low in comparison with the figures for other gases.

Professor Onnes deduces a critical temperature not much higher than 5 degrees Centigrade. But with regard to this and all the other figures he says that more careful measurements and calculations must be made before any certain and final conclusion can be reached. At temperatures so near to the absolute zero there is always room for doubt in the application of laws deduced from the behavior of bodies in more normal conditions, and for the present we must apparently be content to accept the values of the helium constants as provisional.

[1] From the London *Times*.

SPECIAL ARTICLES

A NEW GROUP OF PERMIAN AMPHIBIANS

More than thirty years ago the late Professor Cope described from the reputed Permian, of Illinois, three small vertebræ which he considered reptilian and which he made the type of the genus and species *Lysorophus tricarinatus*. Six years ago Professor Case recognized in certain material—a considerable series of connected and more or less intertwined vertebræ—which he had collected from the Permian of Texas, the same genus, and, possibly, the same species. He reached the conclusion that the animal was

legless and serpentiform in shape. In the absence of the skull, he referred the form, as Cope had done, to the Reptilia. Two years later F. Broili thought that he recognized in some imperfect skull material of the same species a pair of flat bones below the palatal region, which he believed to be gular plates. As such plates are characteristic of fishes and unknown in reptiles, with which he also classed the genus, he reached the rather startling conclusion that the reptiles were, in part at least, derived directly from the fishes—a conclusion, it is needless to say, which was received with doubt and incredulity by naturalists. Because of this extraordinary character he proposed for the form the family name Paterosauridæ.

Recently, in the examination of the Texas Permian material in the Chicago University collection, I was so fortunate to find a skull of *Lysorophus* in connection with vertebræ, which, upon preparation proves to be wonderfully perfect and complete. The so-called "gular plates" of Broili are merely and clearly four pairs of epibranchials, all nearly of the same size, the first pair only with a stout pair of ceratobranchials connected with them. Upon the whole the branchial apparatus resembles not a little that of *Necturus* or *Proteus;* and indeed there are certain other resemblances to these salamanders in the skull that can not be overlooked—the small, pointed snout, the very small size and anterior position of the orbits and nares, especially. The temporal region is unossified; the basioccipital is ossified and there are two occipital condyles. There is no pineal eye; and there is a pair of large plates, apparently proatlantal, back of the small, unpaired supraoccipital.

Lysorophus was a slender, well-ribbed, serpentiform, legless, probably blind, mud-burrowing amphibian, with long, one-headed ribs attached neurocentrally, and with notochordal vertebræ, strangely resembling, though genetically very distinct from, the modern Cæcilia. In skull structure it is not unlike modern amphibians, but will doubtless require the erection of a new group for its reception, a group equivalent to the modern Cæcilia. In length the creature may have reached a foot or fifteen inches, though the skull measures but a trifle more than half an inch.

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COMBINATIONS OF ALTERNATIVE AND BLENDING INHERITANCE

WHETHER blending and alternative inheritance are fundamentally the same thing or not, they are usually sharply to be distinguished in their end results. Mendelian work has been almost wholly concerned with alternative inheritance. However, usually each member of the Mendelian pair exhibits fluctuating variation. Tallness of peas is dominant in a Mendelian sense over dwarfness, but each sort varies as to height. When either condition is pure (homozygous) only blending inheritance is concerned. When the two conditions are crossed we have to consider a combination of both alternative and blending inheritance.

When the ranges of variation of the two conditions do not overlap no confusion would occur. However, when they do, although Mendelian segregation and purity of germ may be as perfect as ever, confusion would arise. In the beetle *Crioceris asparagi* there are three pigmentless areas on each elytron. These areas may be distinct or they may be united in various degrees. Usually it is the anterior and middle area which unite. They may be well united, or only faintly so, or not united at all but extra large, or they may not be united and small. It seems[1] that the condition of areas-distinct-and-small is a Mendelian dominant over areas-united. However, the recessive character is subject to the fluctuation just mentioned and the inheritance of these fluctuations is a problem of blending inheritance as contrasted with the problem of areas-distinct *vs.* areas-united.

I have been carrying on a study of the inheritance of abnormal venation in *Drosophila ampelophila* for about forty generations of the fly. As was pointed out in a preliminary report of the work before the Boston meeting

[1] Lutz, *Psyche*, June, 1908.

of the International Zoological Congress, we have here the difficulty in applying Mendelism that the range of variation of the recessive character (extra veins) includes, in its somatic manifestation, the lominant characteristic, so that when the recessive character is not well developed we get, even in strains supposedly "pure" with respect to the recessive character, flies that somatically lack the extra veins. However, the degree of development of these extra veins is inherited and the study of such inheritance is a typical one of blending inheritance. Since the degree of development of the abnormality is inherited there must be a correlation between the potency of the "determiners" in the germs and the soma from which these germs came, also between them and the soma they produce. Flies having slight abnormalities produce germs tending to have the abnormality-producing factor weak. When such flies are mated with flies which lack the factor the zygote is so weak with respect to the factor that few, if any, of the offspring are abnormal. However, if flies, producing germs strong with respect to the factor, are mated with flies lacking it, abnormals will be produced. In other words, we have imperfect dominance. This theory of imperfect dominance possesses the advantage, from the Mendelian's view-point, that one does not have to give up a fundamental principle of Mendelism—segregation or purity of the germ. An explanation of certain cases of latency, such as the carrying of pigment possibilities in white animals where albinism is recessive, is also suggested. For example, the spotted condition of guinea-pigs varies in a negative direction until pigment is to be found only in the eyes or in a very small part of the skin,[2] hence presumably beyond this point, when, although it is germinally present it is not somatically evident.

In other words, when the ranges of variation of Mendelian pairs overlap, the Mendelian phenomena will be masked, owing to the inability of the experimenter to properly classify his material. Nevertheless, the fundamental principle of Mendelism—segregation—may still be operative. For example, Castle[3] concluded that the inheritance of polydactylism was *neither* alternative nor blending. May it not be *both* alternative and blending? The distinction seems theoretically important.

[2] Castle, 1905, Carnegie Pub., No. 23.

[3] 1906, Carnegie Pub., No. 49.

Frank E. Lutz

Distribution of Diabase in Massachusetts

No diabase is found west of the Triassic. In the Triassic and east to a line N. 10° E. through the Brookfields is a "Hunne diabase" with two pyroxenes—an augite and a white diopside and feldspars in two generations.

Next east a series of large dykes runs N. 20° E. through Spencer nearly across the state, of a micrographic Hunne diabase, *i. e.*, a rock closely like the above, but containing often abundantly quartz and orthoclase intergrown.

The two types repeat the relations of the western bedded diabase and the Palisade diabase in New Jersey, as recently brought out by Mr. T. Volney Lewis, at the winter meeting of the New York Academy of Sciences. Next east in Massachusetts a band of olivine diabase runs north from Blackstone half across the state.

All the remaining eastern part of the state east of a line drawn about N. 10° W. from the northeast corner of Rhode Island is occupied by a normal diabase, with augite and feldspar in one generation, no olivine or micrographic structure, rich in iron, often showing long rows of octahedra; much weathered and running to coarser grain, and in part of pretriassic age.

Again, in addition to the nepheline rocks around Salem, an interrupted band runs N. 10° W. from Woonsocket, near the northeast corner of Rhode Island, across Massachusetts and into New Hampshire, and the olivine diabase mentioned seems to be in relation with the same. These rough notes are presented as a preface to a request that any one having slides of diabase from Massachusetts would kindly send to the writer information as to whether the same contains olivine, diopside, micrographic or porphyritic structure.

The writer would also value information about any nepheline rocks in Massachusetts.

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A SIMPLE ATMOMETER

FOR determining the differences between the evaporating power of the air in different localities, as in the case of studies dealing with the relation of meteorological conditions to plant growth, the atmometer here described has proved very satisfactory. This instrument utilizes a porous clay bougie for the evaporating surface, after the manner of an atmometer devised by Babinet and described in 1848.[1] It is a modification of a form independently devised by the author for physiological purposes, and described in Publication No. 50 of the Carnegie Institution, 1906.

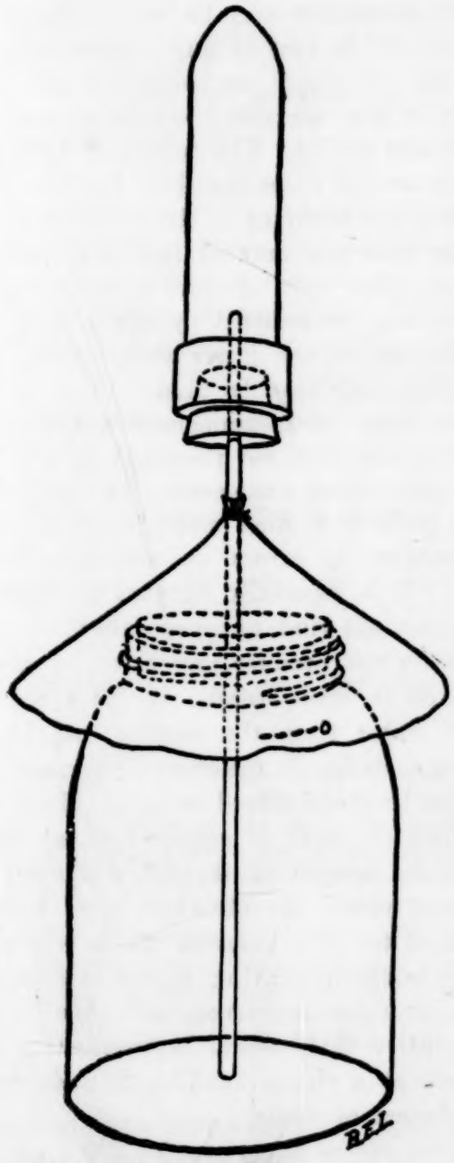

FIG. 1. Porous Cup Atmometer

The bougie is about 13 cm. long and 2.5 cm. in diameter, closed and rounded at one end and reinforced at the other by a thickened rim. The wall, of unglazed porcelain similar to that used for filter tubes, is about 4 mm. in thickness. The open end is closed by a perforated rubber stopper bearing a glass tube about 30 cm. in length, which extends through a cork stopper nearly to the bottom of a glass jar of the "Mason" pattern. Any bottle will serve as well, and a graduated flask serves better, but the "Mason" jar was adopted because of the ease with which it may be obtained almost anywhere in the United States. To allow access of air to the jar, the cork stopper should fit the latter somewhat imperfectly, or should have a slight groove cut in its margin. Above the jar the tube passes through a conical cap of cloth which is rendered water-proof by means of shellac. This serves to shed rain water and to prevent its direct entrance to the jar. An external filemark on the jar, near the shoulder (*O* in the figure), serves as a fixed water-level. A pint, quart or half-gallon jar is used, according to the evaporation rate and the time period during which the instrument is to operate without refilling.

In setting up this instrument, the jar is partially filled with distilled water, the bougie (which has been soaked in distilled water to remove air) is filled and its stopper inserted with the glass tube, the tube is filled, and its free end quickly thrust to the bottom of the jar. In the last operation air must not enter the tube. The jar is next filled to the filemark, the cork stopper placed in position, and the instrument is ready for operation. When the apparatus is thus arranged, the water films closing the pores at the outer surface of the bougie possess a tensile strength adequate

[1] Babinet, J., *Compt. Rend.*, **27**: 529–30, 1848.

to prevent penetration of air through the walls, and the bougie remains filled with water, although it is above the water-level in the jar. Evaporation proceeds from the surface of the bougie, water being drawn into the pores to replace what has been lost. The water thus removed from the cavity of the bougie is in turn replaced from the reservoir, and evaporation may continue as long as the tube reaches the water in the latter.

After the lapse of a time period the cork stopper is loosened, slightly raised, and slipped sidewise as far as the tube will permit, its lower surface resting on the edge of the jar. The latter is then refilled to the standard level from a graduated vessel, and the amount of water required to refill is the amount which has been evaporated during the preceding period.

Only pure water is to be used in this instrument, for otherwise a rapid clogging of the pores of the bougie ensues. Water from an ordinary still is satisfactory. To prevent the growth of microorganisms in and on the bougie, which might clog the pores, formaldehyde may be added to the water, to make a 3–5 per cent. solution. This does not interfere appreciably with the operation of the instrument. The bougies, as received from the factory, are, of course, not strictly uniform in porosity, and it is necessary to standardize them by comparing their evaporation rates, under uniform conditions, with that from a standard bougie. The latter is not used excepting for standardizing, and is kept protected from dust and moisture when not in use. A coefficient of correction is obtained by standardizing, which is applied to the readings obtained in actual operation. If properly used the bougies will operate for at least four months without appreciable alteration in their coefficients of correction. It is well, however, to restandardize them at the end of a season's work.

When exposed in the open, rain may fall upon the surface of the bougie, and as long as this surface is wet the water movement in the instrument is reversed, and water actually enters the jar, at a rate determined by the porosity of the bougie and by the height of the water-level in the jar at the time. This error, is, however, very small excepting for long periods of rainy weather. A correction coefficient may be obtained and applied, but the application must depend upon a record of the duration of precipitation periods. Of course the error here mentioned might be avoided by placing a small screen above the instrument, but such a screen would alter the evaporation rate to some extent, even though it were made of glass, and, since the influx of heat from the sun in different localities varies to a marked degree, a screen is not desirable.

This atmometer may be read daily, weekly or monthly, in fact at any convenient intervals, the only condition being that the water-supply in the reservoir must be adequate for the chosen period. The tube may be lengthened to several times the given length without affecting the accuracy of the readings, so that a large reservoir may be used for very long periods. The rate of water loss from the bougie may be reduced by partially coating the surface of the latter with shellac, or a smaller bougie may be used.

This form of instrument has few of the objectionable features possessed by the common open vessel atmometer. It does not attract birds and other small animals and is not subject to errors on account of their visits. It is especially adapted to studies of the effect of wind on evaporation, for high winds do not produce any error, as they so often do in open vessels, by the blowing of liquid water from the surface and by producing variation in the effectual surface itself. It may be standardized so as to give results in terms of depth of evaporation, as usually given, by comparing it with whatever form of open vessel the observer may choose as standard for this purpose. It is self-recording and self-integrating, as far as data for a mean rate are concerned, and, finally, is so inexpensive that several instruments may be exposed at a single locality, thus decreasing the chance of error.

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